Dealing with 100 years of tribal knowledge*

(*words stolen from Robert Beinefeld)

Plug-in Hybrid & Electric Vehicle Research Center

phev.ucdavis.edu

PH&EV Center Research teams and research partners

Consumers

- Lifestyle studies
- Market demand
- Usage patterns
- CEC, BMW, ARB

Dr. Kurani

Fleet Development

- Market Segments
- Fleet Operation
- Energy Savings
- Chrysler, DOE

Dr. Nesbitt

Battery studies

- Benchmark Testing
- 2nd use
- End of life
- DOE, NREL, Aerovironment, UCB, UCSD, SDGE

Dr. Burke

Spatial & Temporal PEV Energy Use

- GIS analysis
- Charging network design
- CEC, Nissan, INL, ECOtality

Dr. Nicholas & Dr. Tal

Human Machine Interfaces

- Response to HMI design
- Benchmarking
- ARB, ORNL, CEC

Dr. Stillwater

Beginning to compare regions & cities trying to make PEVs happen

1. Partnership:

   International Energy Agency, Clean Energy Ministerial Electric Vehicle Initiative,(16 Energy Ministries), Clinton 40, Rocky Mountain Institute, PH&EV Center

2. WECE Website

   20-24 cities, data sharing, project showcasing

3. WECE Conference

   Los Angeles May 5 2012

   Amsterdam, Shanghai, Stockholm, Barcelona, Lisbon, Shenzhen, Tokyo, Hamburg, Victoria, Portland, San Diego, Los Angeles

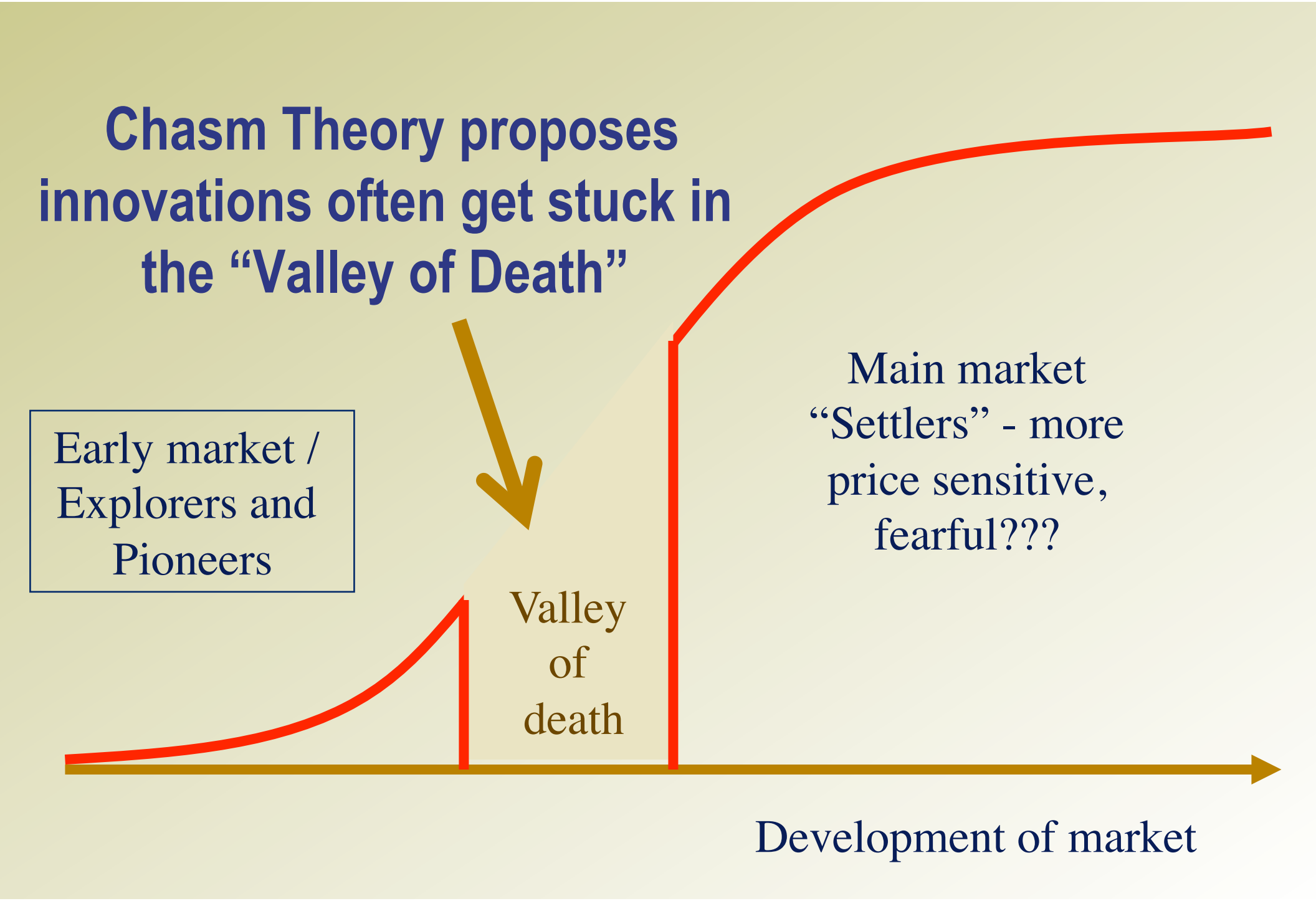
Automobility

- 100 year system of petroleum, internal combustion, roads.
- Important practical and lifestyle tool, mobility, public symbol of household success.
- 100 years of “tribal knowledge” of users, makers, etc..
- World total fleet 6-700 million / World Annual Sales 75 million
- Many brands, types, 100s of models, brutally competitive, big investments
- Slow turnover (10-15 years) –saturation and declining sales in US, Japan, Europe..first buyer sales in China, India, Eastern Europe, South America

Buyers are confronted with new, complex choices

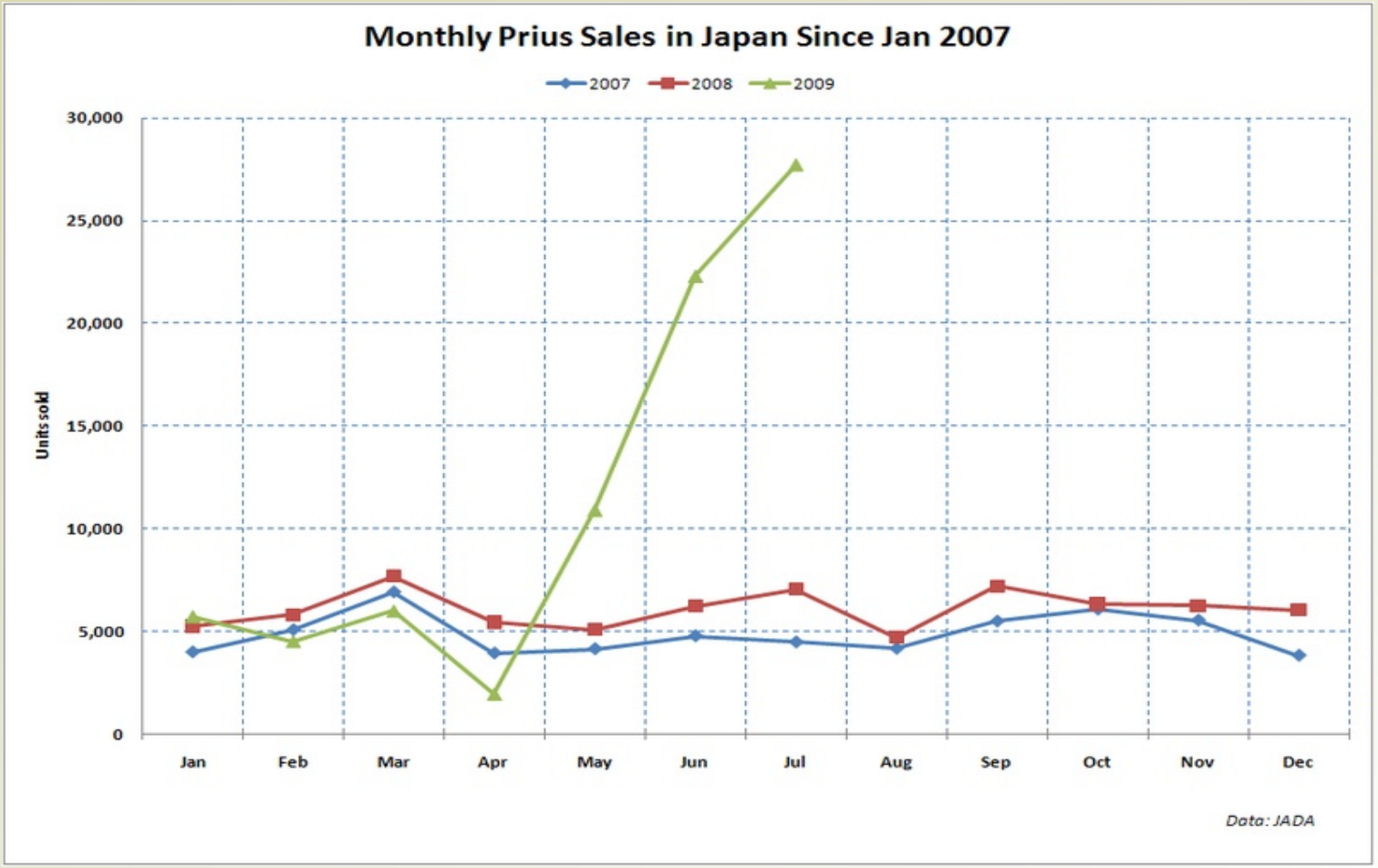
Difficult choices

- **Driving range & refueling:**
  - PHEV dual fueled, 20-100 km of EV range, blended designs
  - BEVs – big range of ranges 50-300 km when full discharged
- **Electricity:** costs ($.03-.30 kWh), dashboard displays, sounds; drive feel; plug in where they park,
- **Vehicle uncertainty:** safety, batteries, durability, cold and hot climates, will people think I'm smart?
- **Complex social & environmental benefits**:
  - Greatly reduce petroleum use;
  - Zero tailpipe for BEV,
  - GHG emissions vary by regions


Chasm Theory proposes innovations often get stuck in the "Valley of Death"
Early market / Explorers and Pioneers
Valley of death
Main market "Settlers" - more price sensitive, fearful???
Development of market

Did HEVs cross the chasm in Japan?
Why is the Prius the best selling vehicle in Japan?
(since 2009, 35,000-7% of sales in Feb 20112 20,500 12th in US)

- About $100,000 yen/ $1100 incentive
- Public values and knowledge were developed



Why are 50% of US Leaf & Volt sales in California/

- Price of vehicle is lower? More affluent?
- Price of gas is higher? Lower price of electricity?
- More incentives to buyers? (rebates, tax credits, HOV lanes, free electricity/ parking?)
- EV ready? (charge system in place?)
- Regulations? (ZEV program)
- Tree huggers..liberals..techies..
- 5 times as many innovators?

In 1090s, Tom and Ken study potential buyers of EVs, some buyers of CNG

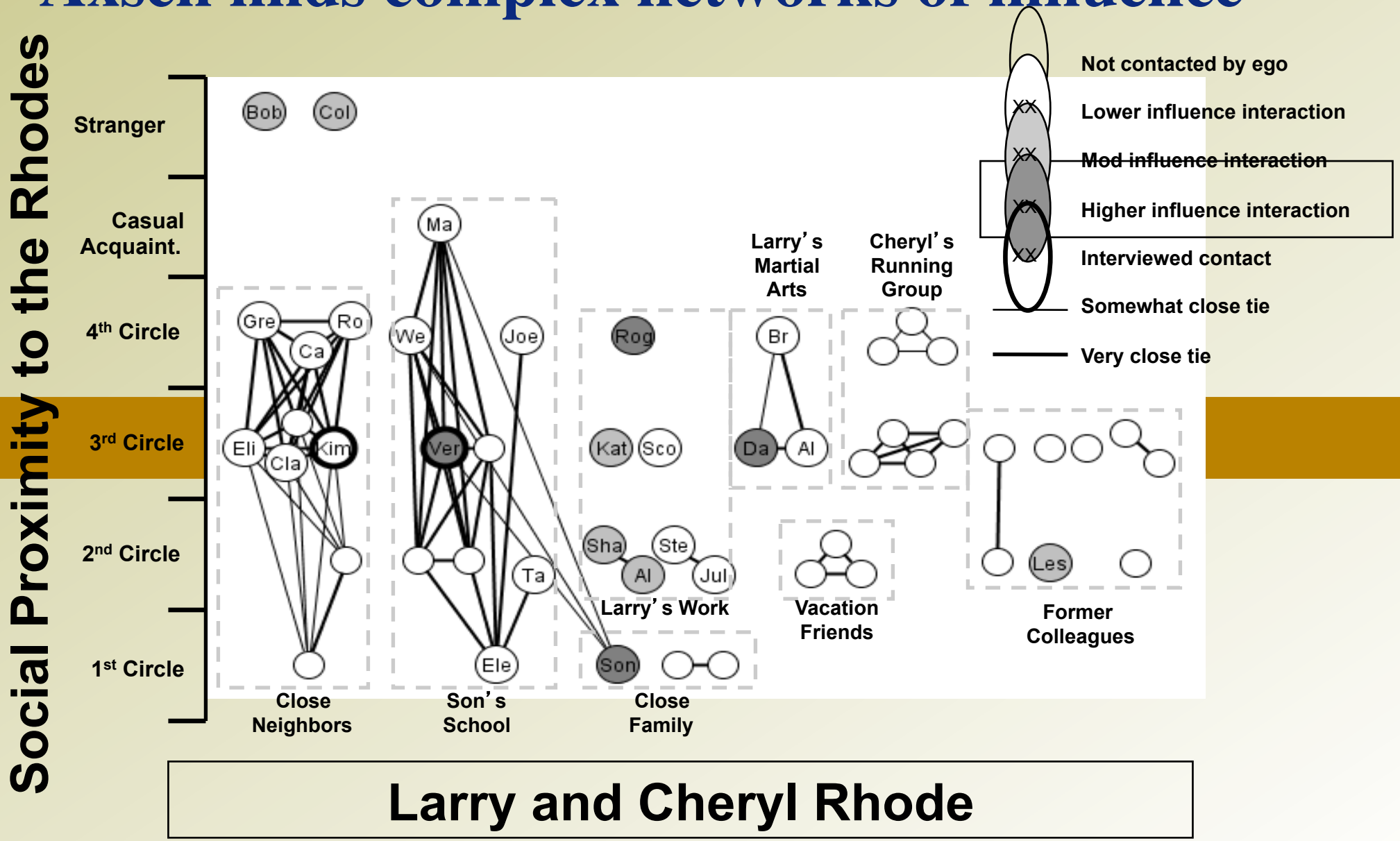
- Tom & Ken ..1990s: focus on practical decisions of fleets, pioneers, probable buyers of CNG, diesel, EVs, PHEVs, about range, refuel/recharge, low speed EVs, “city “ EVs.

  Concept of range elusive without direct experience, households talk about “critical” trips, routine activity space, safety buffers, main market is probably “hybrid households”
- Buyers not interested in CNG, Methanol unless it saves money.
- EV driving experience and concept of using electricity as fuel has some spark

ITS researchers finally learn about real decisions..

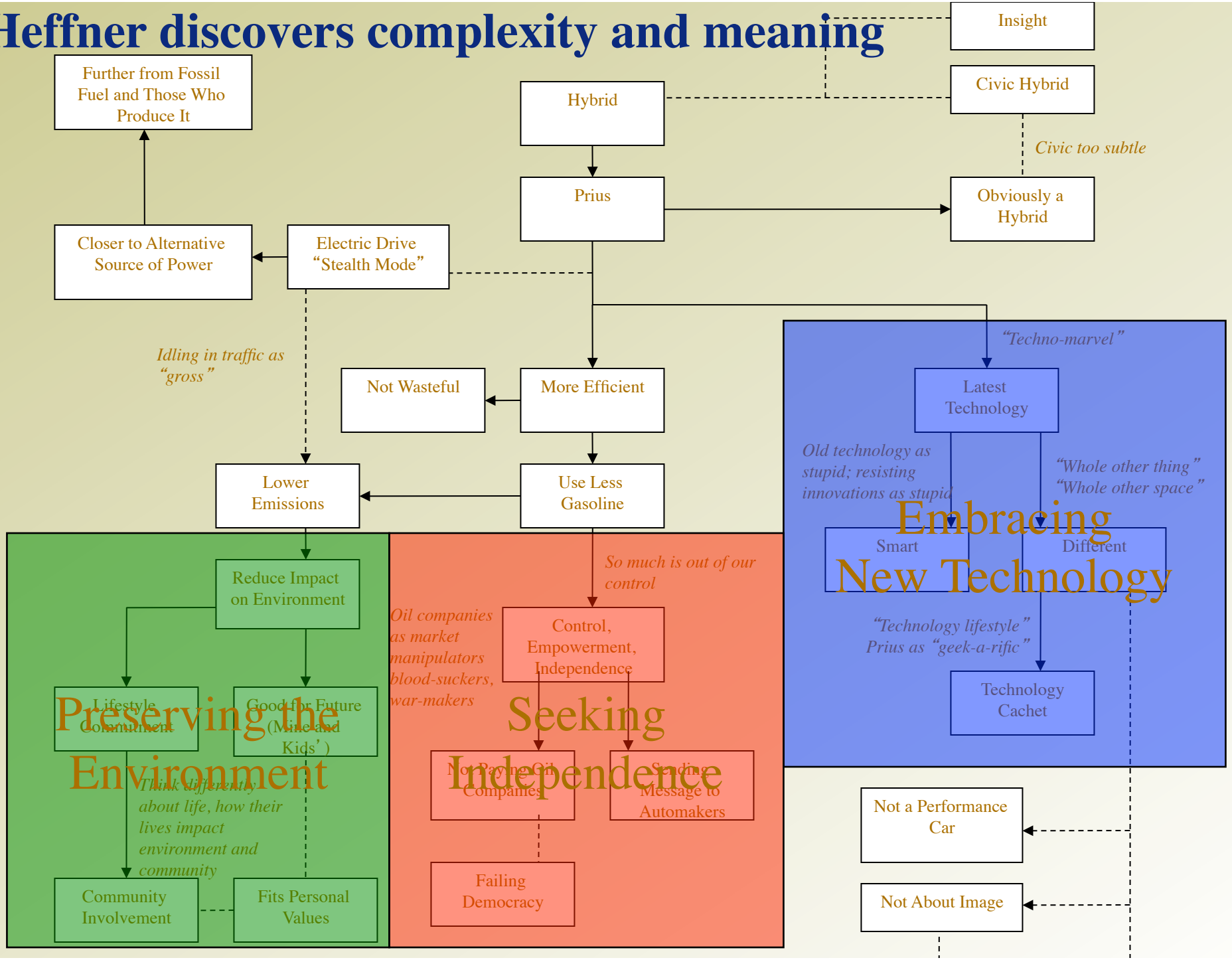
- **Heffner era**- HEV “purchases”
  - Buyers talk less about practical aspects. More about “meaning”
- **Ken and Tom** - Fuel economy decisions
  - No book keeping, no knowledge of annual fuel costs, focus on pump price and tank price
- **Axsen era** – AFVs and PEVs in social networks. Two concepts:
  - Liminality: openness to change (decisions in life context)
  - Translation: drivers fitting technology into their lives…
- **Kurani and team** – Focus on “narrative”,
  - the story driver’s construct to explain and direct their decisions…
- **Turrentine and team** – BMW MINI-E
  - “fun and clean”, “energy use mastery,” my EV space

Axsen finds complex networks of influence



Larry and Cheryl Rhode

Heffner discovers complexity and meaning



We learned how households change driving patterns with Mini E.

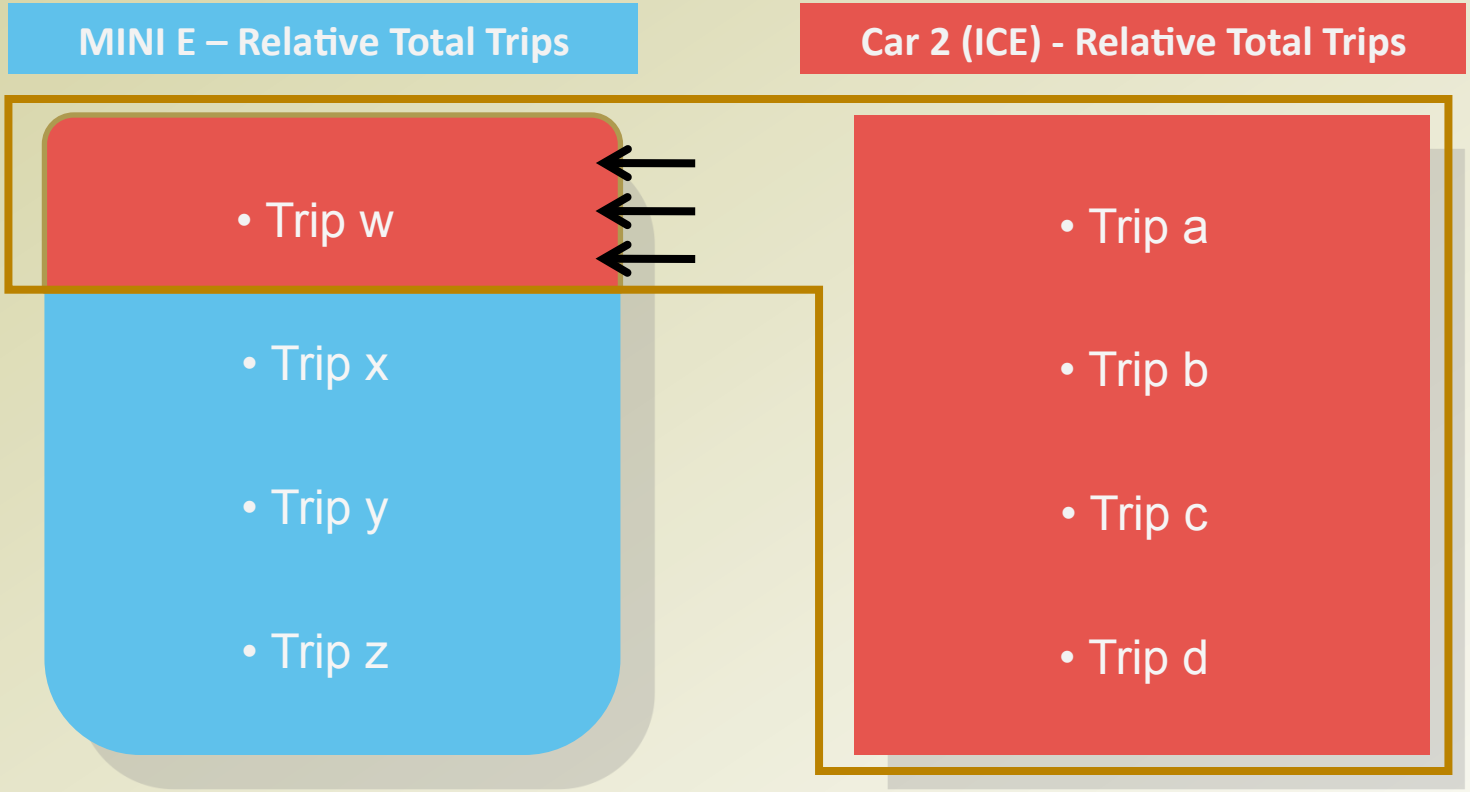
Car 1 (ICE) – Relative Total Trips

- Trip w
- Trip x
- Trip y
- Trip z

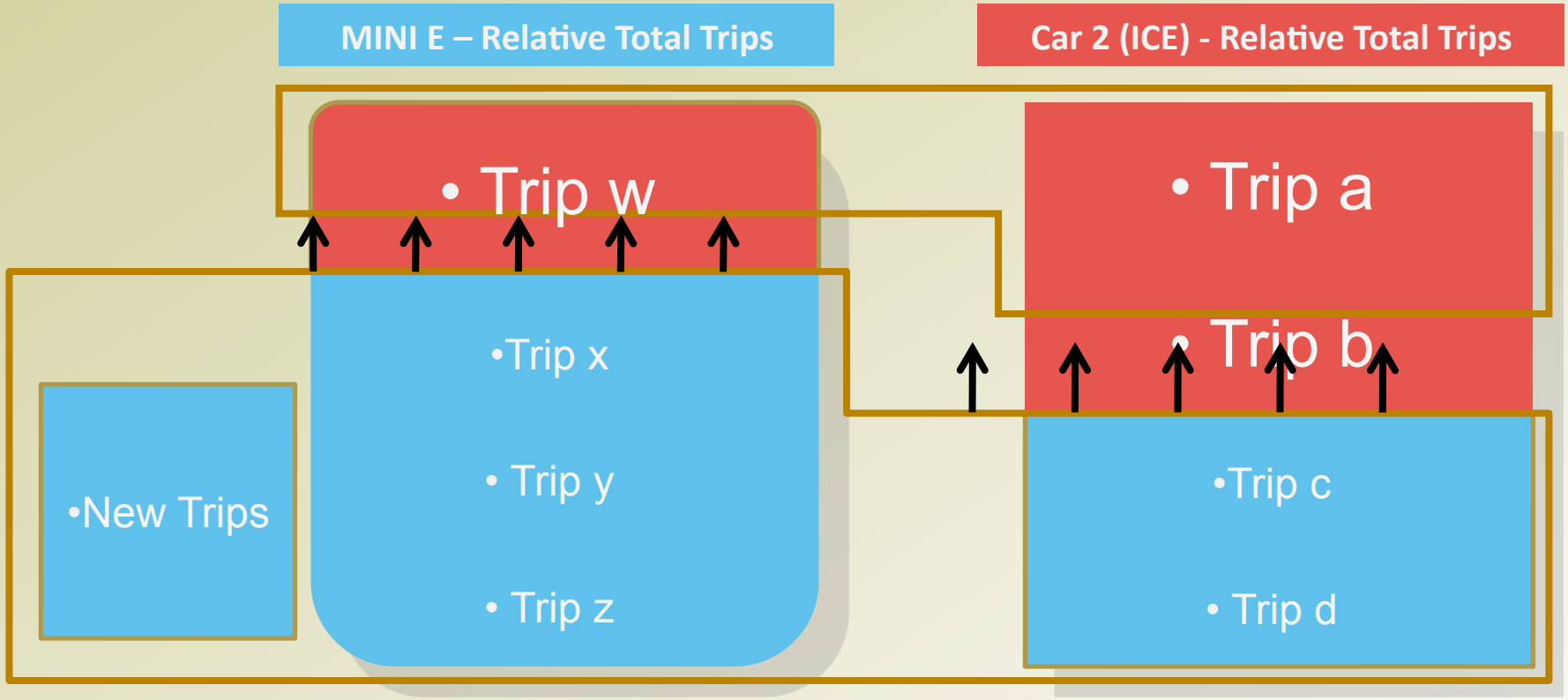
Car 2 (ICE) - Relative Total Trips

- Trip a
- Trip b
- Trip c
- Trip d

Longer trips shifted to Car 2



Some of Car 2 trips shifted to Mini E



Recent survey - Gil Tal, Mike Nicholas and team

- EV project in San-Diego (Ecotality)
- State rebate program (CCSE)

Response numbers:

Nissan Leaf	1076
Chevrolet Volt	32
Tesla Roadster	21
Total	**1129 PEVs**

Households Characteristics (based on an early subsample of 637)

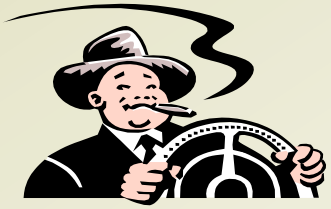
- 96% live in single family House
  - 95% own their house

- 42% have solar panels
  - 18% consider installation
  - 40% have no plan to install

- Average Household size 2.7
- 83% have yearly income income higher than
  - 46% incomes is higher than $150K
  - 16% decline to state.

Average driver looks like Tom (with more money)

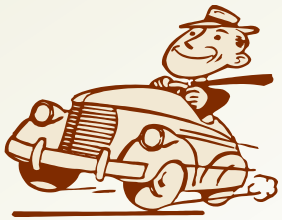
- Average age of a LEAF driver is 50 years old but *only 10% are over 65* (N=1003)



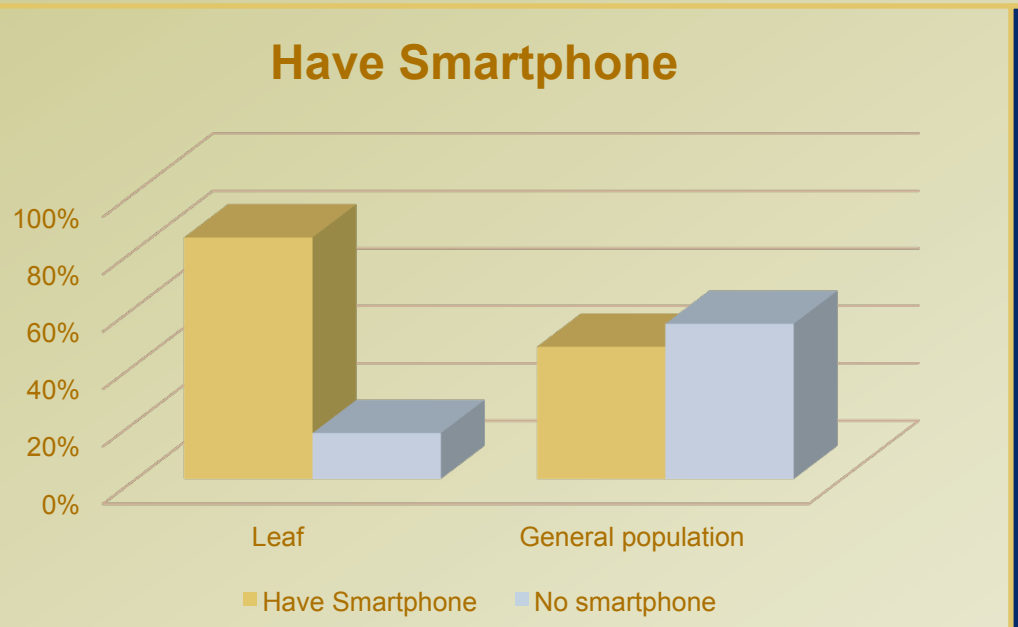
- In 80% of the households the main LEAF driver is Male.

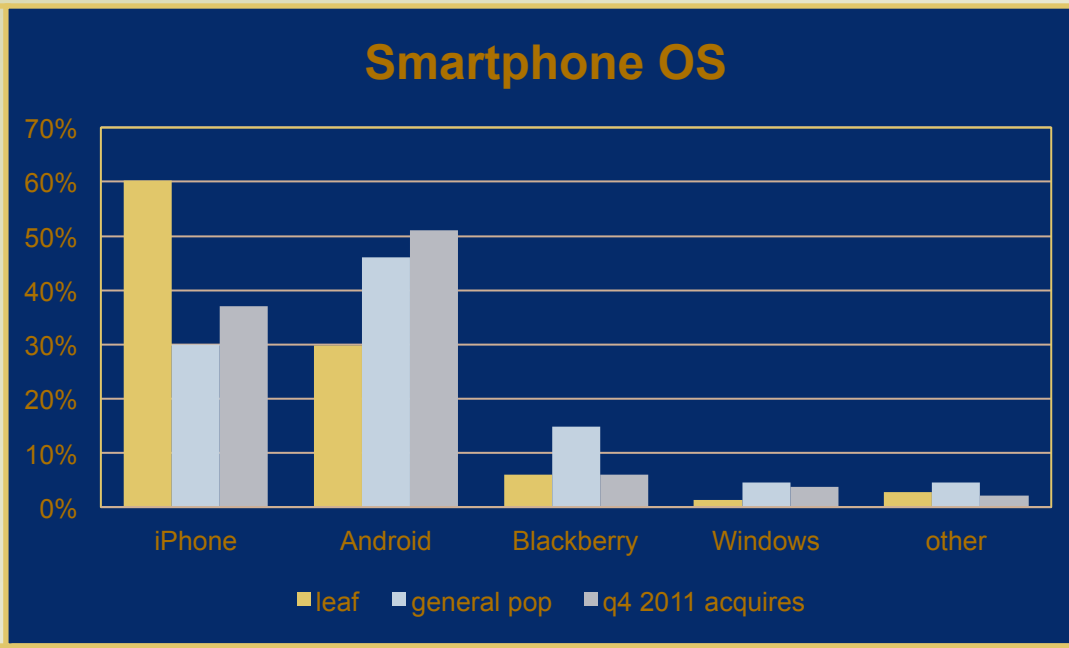
- On average, the main driver is using the car 76% of the time.

- 22% of the vehicles are used by single driver.



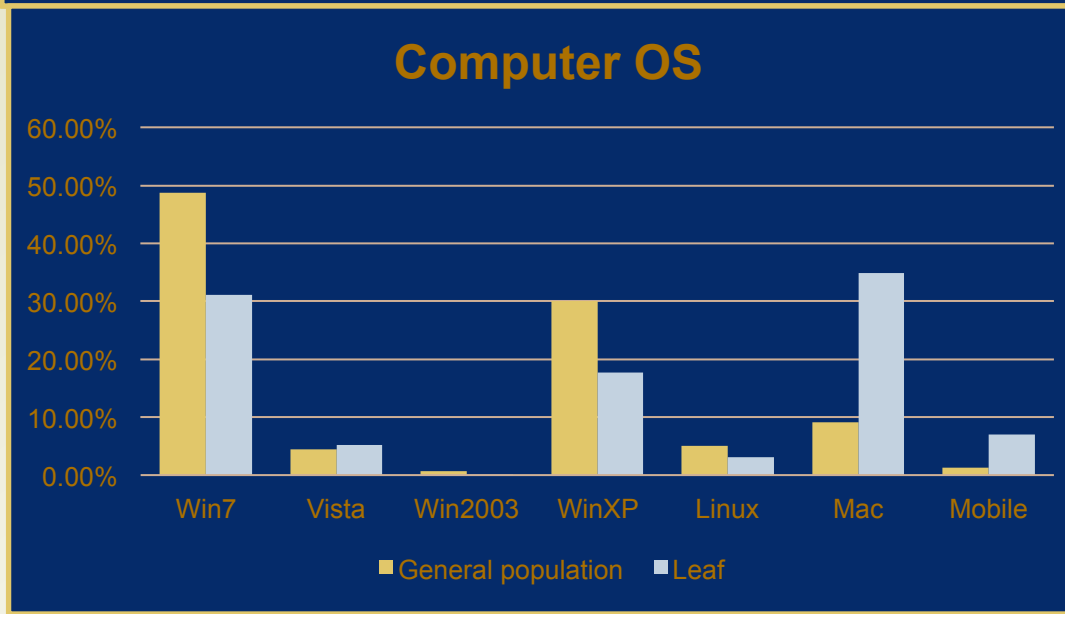
Leaf buyers have smart phones and techy stuff..



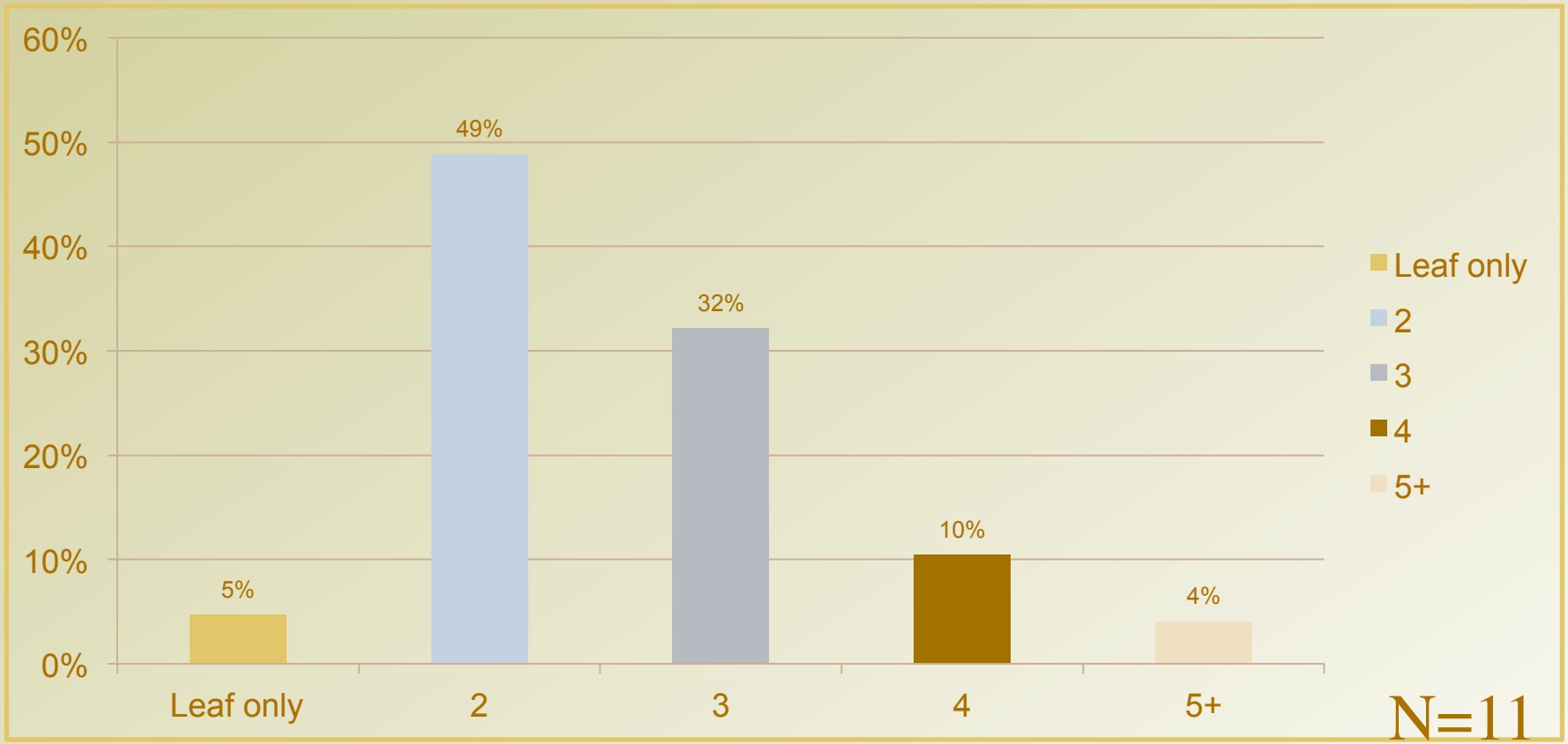


Leaf Owners Vs. General Population

- More Smartphones
- More IPhones
- Newer Computers
- More Macs



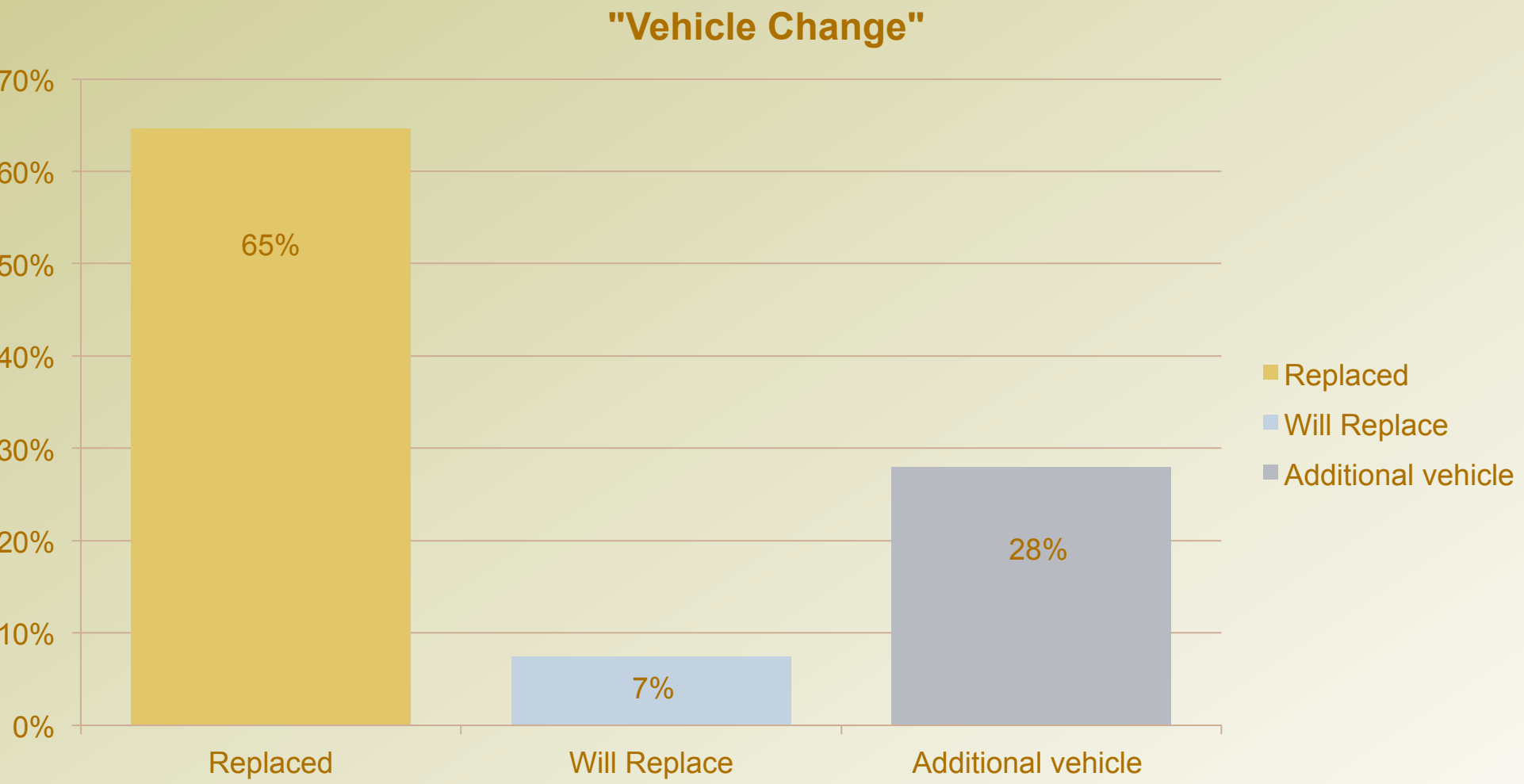
Households are combining HEVs and EVs



N=11

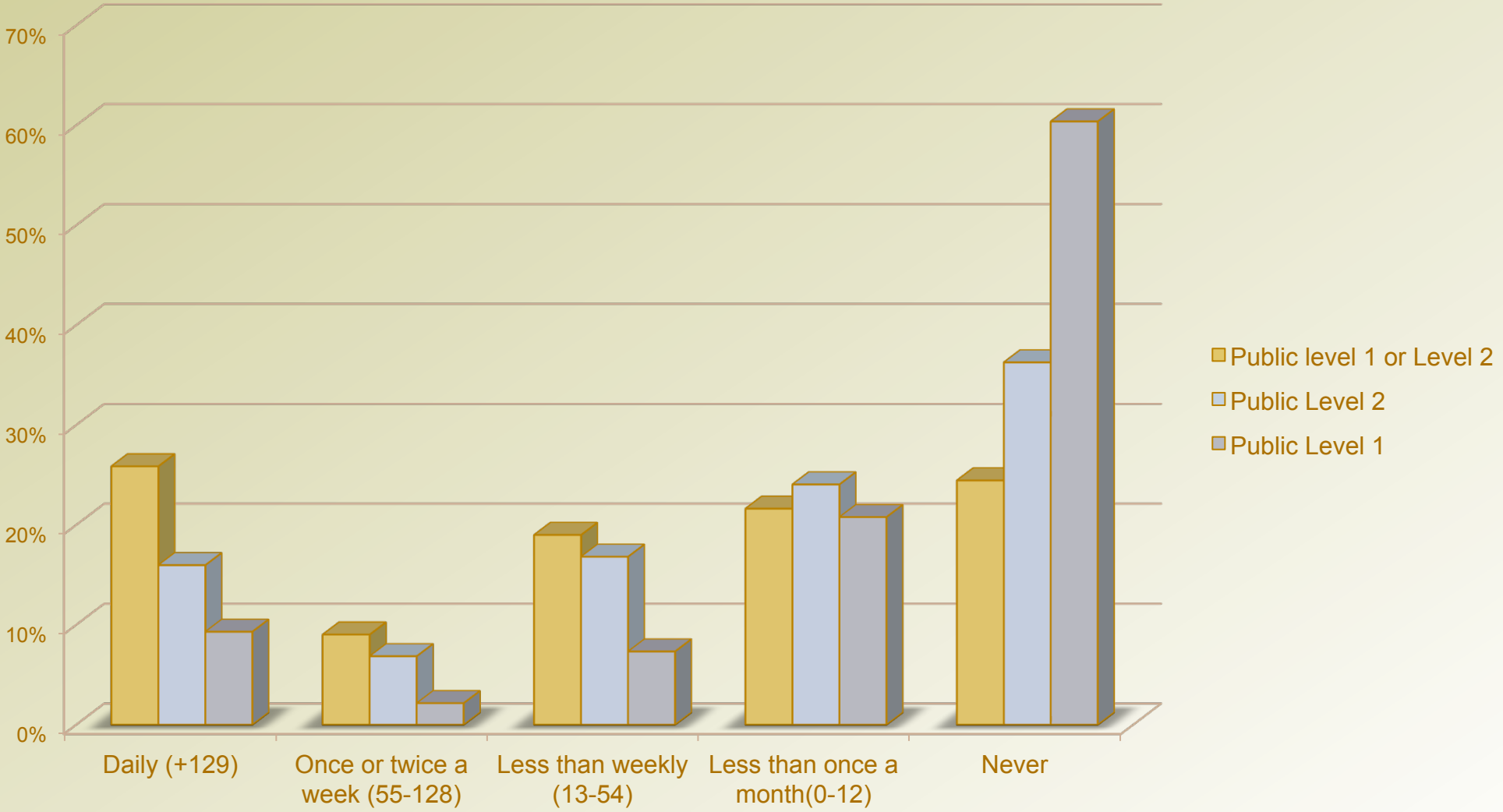
- 23.8% of the EV household also own a Hybrid.
- 9.1% of LEAF owner have another Nissan.

Household Fleet Changes with the LEAF



- 19.4% of the replaced vehicles are hybrid
  - But 35% of those have a second Hybrid in the household

Not using Level 2 very often
(has much to do with 3.3 kW charger in Leaf)



Most want DC fast charge

271 Respondents

	Charger 1	Charger 2	Charger 3	Charger 4	Charger 5	Total by Type
DC Fast	116	111	93	79	74	473
Level 2	66	37	32	24	17	176
Total Chargers	182	148	125	103	91	649

We are looking at energy feedback devices impact on driving and vehicle choices as well

- 2009 Scangauge field test

(~6 drivers, 6 months).

- 2008-9 Prius field test with V2Green Gridpoint website

(~60 households, 1 month each).

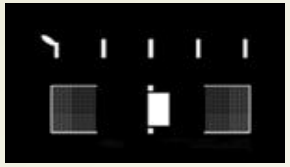
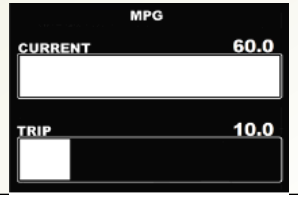
Energy Monitor and Consumption screens of Prius. Accessed through "Info" button.

- 2009-10 UC Davis custom HMI

(~40 drivers, 1 month each)

Tai and Ken are studying hardware …

- **Currently Running Large Sample (150 household) feedback test along the I-80 Corridor funded by ORNL/ DOE**
  - Using the DashDaq data display and logger
  - Custom screens test both the effect of "raw" information and contextual feedback
  - Direct test of 3 common designs

Screen Name	Operational Description	NHTSA Scores	NHTSA Name and Image
"Accelerator"	Instantaneous acceleration bar and trip-level leaf representation of fuel economy.	High comprehension, low load, high satisfaction, uncommon in application	CSO2 
"Shrubbery"	Short term and trip-level leaf representations of fuel economy.	Moderate Comprehension, moderate load, high on satisfaction, uncommon application	CSO3 
"Numbers"	Instantaneous and trip-level fuel economy in horizontal bar format.	Moderate on comprehension, moderate load, low on satisfaction, common in application	CSO6 

And smart phone applications as well..

- **Smartphone-based feedback for a larger evaluation of multiple metrics and styles.**
  - Smartphone platform enables our lab to create intricate custom designs at a very low per-subject cost.
  - Currently finalizing funding from the ARB and the Bay area MTC (MPO) for a 750 participant study starting summer 2012.